Immunization Coverage of Albertan Children in Care of the Government

by

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Abstract

Background: Children in care of the child welfare system ('children in care') are a vulnerable population who access preventive health services less than children not in care.

Objective: To assess immunization coverage of a cohort children who have been in care in Canada and compare it to children who have never been in care.

Methods: Three population-based administrative datasets were linked to assess immunization coverage for children at age two (N=44 206) and seven (N=42 241) for diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae type b* (DTaP-IPV-Hib), meningococcal, and measles, mumps, rubella (MMR) vaccines. A child was considered to be in care if they spent any time in care before the age of assessment. Logistic regression was used to compare immunization status.

Results: Immunization coverage for children in care at age two ranged from 54.3% (DTaP-IPV-Hib) to 81.4% (MMR) compared to those not in care which ranged from 74.2% (DTaP-IPV-Hib) to 87.4% (MMR). Coverage for children in care at age seven was 53.1% (DTaP-IPV) and 65.3% (MMR) compared to those not in care 76.6% (DTaP-IPV) and 83.4% (MMR). For both ages, the odds of being under vaccinated were higher for children in care for all vaccines (e.g. DTaP-IPV-Hib odds ratio [OR]: 2.43; 95% confidence interval [CI]: 1.72-3.44). For children not in care that live in households with competing demands (e.g. highly mobile lifestyle), their coverage was lower (e.g. 63.1% for DTaP-IPV-Hib) than those not in care without such demands (e.g. 76.4% for DTaP-IPV-Hib) but higher than children in care. Among the three groups, children in care had the highest odds of being under vaccinated (e.g. DTaP-IPV-Hib, OR: 2.72; 95% CI: 1.93-3.86).

Conclusion: Children in care have lower immunization coverage than children not in care. Policies and practices should be examined to ensure optimal access to vaccination for these children.

Preface

This thesis is an original work by Jennifer Sarah Hermann. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Immunization Coverage of Albertan Children in Care of the Government", No. Pro00069172, November 22, 2016.

Chapter II of this thesis is to be submitted for publication to *Pediatrics* with fellow authors CA Bell, KA Simmonds, and SE MacDonald. If not accepted to *Pediatrics,* publication will be pursued in a different academic journal. JS Hermann was responsible for data analysis and manuscript composition. CA Bell was responsible for data collection and contributed to manuscript edits. KA Simmonds conceptualized the study, contributed to data analysis and manuscript edits. SE MacDonald was the supervisory author and oversaw data analysis and manuscript composition.

Dedication

To Mom and Dad, thanks for your never-ending support, especially during these past two years;

and to Oma who set the bar high when it comes to grad school.

I was inspired to follow in your footsteps.

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Glossary of Terms

Key terms used in this thesis are defined below. Operational definitions of variables examined in the data analysis are provided in the Methods section.

Child welfare is a broad term that encompasses government and private agencies that provide supports and interventions to encourage family stability and ensure the safety of the child, most often with the goal of protecting the child from abuse and neglect;[1]

Child welfare interventions are the supports and actions taken by government and private agencies to ensure the safety of the child;

In care, also commonly referred to as out-of-home care, is considered to be a time when the child has been removed from the family home of the parent or guardian due to concerns of safety, abuse, and/or neglect and is in the government's care. When children remain in their family home with their parents or guardian, though receiving child welfare services, they are not considered to be in care of the government;[2]

C*ompeting household demands* refers to families that have experienced challenges such as: single marital status, young maternal age, large number of children, and multiple household moves; and

Immunization coverage is the proportion of the target population who have received the intended vaccines.

Chapter I: Introduction

Introduction and Overview

The purpose of this study was to identify immunization coverage of children who have been in care of the government (e.g. foster care and kinship care) in an Alberta birth cohort, and to determine if there was an association between care status of children and immunization coverage. This is a 'paper-based' thesis and is comprised of three chapters. Chapter I provides the context of the problem, the purpose of the research, the guiding framework, the design and methods, and a literature review. Chapter II is a manuscript that was prepared for submission to a peer-reviewed journal. This manuscript covers the main results of this study. Chapter III provides an overview of the results, significance, limitations, and recommendations resulting from this thesis research.

The Problem

Children in child welfare are a vulnerable group.[3–6] A subset of these children who are receiving "out-of-home care", those who have been removed from direct care of their parent and/or guardian, are especially vulnerable[6] and considered to be "in care" of the government.[2] In 2013, a national count found 62,000 children in care across Canada,[7] while in Alberta there were just under 8,500 children in care.[8] This group of children face many physical, mental, and emotional health challenges compared to children who are not receiving child welfare interventions.[3,9–11] One way to decrease this disparity is by ensuring adequate access to preventive health services.[12] However, there is indication from the global literature that these children are accessing preventive health services, such as immunizations, at lower rates than those children receiving no child welfare interventions.[13–15] This places an especially vulnerable group of children at a disadvantage in achieving optimal health.[12]

Numerous studies have sought to identify the health needs of this population, with many focusing on the physical, mental, emotional, and behavioral aspects of health. Immunizations are an important preventive health service that have been researched less extensively in this population. This is of concern as immunizations protect against disease but also, as Snow and Lorek[16, p.212] indicate, immunizations can be used as a "proxy marker of general health needs". Literature from the United Kingdom,[17–19] Australia,[10] the United States,[20,21] Italy,[5] and Sweden[22] has addressed immunization coverage of children in care and the majority of literature show that these children are not fully immunized and have lower coverage relative to the general population or children not in care.

In addition to studies assessing children currently in care, one study found that children at the time of entering care of the government were not fully immunized.[23] Literature suggests that factors contributing to poor immunization status on entry into care include neglect[16,19,24] and multiple moves[16] prior to entry into care. There is some evidence that children being taken into care often come from homes with multiple competing demands. A Canadian literature review described characteristics associated with neglect including greater than one child in the home, multiple household moves, caregiver age less than or equal to 18, and no second caregiver in the home.[25]

Previous research has shown that even children not involved in the child welfare system, who have this profile of 'multiple competing household demands' (i.e. maternal single marital status, young maternal age, mother having a large number of live births, and multiple household moves), also have suboptimal immunization coverage.[26] As multiple competing household demands are prevalent in under-immunized children and children in care, it is important to identify differences between immunization coverage of children in care and those not in care

who have multiple competing household demands. This will contribute to understanding the complex factors contributing to the immunization coverage of children in care.

A systematic review of the literature that is in progress,[27] found no research on this specific issue has been completed in Canada. Given that children involved with child welfare have been identified as an at risk group for under-immunization in other contexts,[28] and knowing that political, social, and cultural contexts greatly influence health and social service provisions, it is prudent to see if this is the case in Canada. Identifying immunization coverage in children in care is important, as the government acts as statutory parents,[12] and one role falling to a "parent" is to ensure that their child is up to date in their immunizations.

Purpose Statement

The purpose of this study is to determine immunization coverage of children who have been in care of the Government of Alberta and compare this coverage to Albertan children who are not in care of the government.

Research Questions

Question 1: What is the immunization coverage for children in care in Alberta?

Question 2: Is there a difference in the immunization coverage for children in care and children not in care in Alberta?

Question 3: Is there a difference in the immunization coverage in Alberta for children in care, children not in care with competing household demands, and children not in care from a household without competing demands?

Literature Review

The following literature review provides an overview of immunizations and children in care. Literature that addresses the importance of immunizations and immunization coverage will

be discussed, followed by a description of who comprises children in care and what is known about their health concerns. Previous studies specific to the topic of immunizations and children in care will then be synthesized according to the country where the research was conducted (United Kingdom, Australia, United States, Sweden, and Italy).

Immunizations

The terms immunization and vaccination are often used interchangeably in literature, though scientifically they have different meanings. Vaccination is the process of receiving a vaccine while immunization is what occurs in the body after receiving a vaccine (i.e. the stimulation of the immune system).[29] The choice of which term to use can be based on region, context and/or personal preference. For the purpose of this thesis, immunization will be used, which will refer to the process of receiving a vaccine. For publication purposes, vaccination will be used in place of immunization in the manuscript, as this is the preference of the target journal. Immunization coverage is the number of people (presented as a percentage) who received the vaccine(s) being studied relative to the overall population eligible to receive the vaccine.[30]

Importance of immunizations. Immunizations are an important and effective way to prevent illness and contribute to the health of all individuals. Immunization is said to be "one of the most significant public health interventions in the past century", as well as one of the most cost effective.[31,p.596] Second only to water sanitation, immunizations are credited as having a major effect on population growth and mortality decreases, ranking even higher than antibiotics in its impact.[32] In the United States alone, it has been estimated that immunizations have resulted in the prevention of 103 million cases of childhood diseases since 1924.[33]

Immunization coverage is also important for herd immunity, which occurs when a large enough proportion of the population is immunized so that those non-immunized in the

population also experience some protection.[34] Immunizations have been found to be the most effective approach in reducing the effects of infectious diseases in susceptible populations.[32]

In addition to disease and mortality reduction, it has been suggested that immunization offers broader benefits.[35] These benefits include improved lifetime productivity, as a result of increased capabilities such as improved educational attainment.[35] It is argued that the absence of disease at young ages allows for successes later in life.[35]

Determinants of immunization coverage. Immunization coverage is an important indicator of the health status of a population. It can be used as a proxy indicator for health,[16] as well as a health performance indicator for programs.[17] In spite of their importance, immunization programs are not being fully accessed,[36] immunization coverage is not meeting targets,[37] and disparities in immunization coverage exist worldwide.[28] There are various contextual, personal, and sociodemographic factors that influence whether or not people get immunized.

Contextual factors have been identified as some of the determinants of immunization coverage. Exposure to immunization messaging and information through various means, including media and internet have been found to have both a positive and negative effect on immunization uptake, depending on the nature of the messaging.[38,39] In countries where families must pay for vaccines, cost is a barrier to immunization.[38] Lack of access, including geographic location,[28,39] has also been identified as a major barrier to immunization.[39,40]

Personal factors including, knowledge, attitudes, and beliefs, have also been identified as determinants of immunization coverage. Three systematic reviews identified that beliefs regarding the necessity and importance of immunization are associated with immunization uptake, with lower perceived importance being associated with lower immunization uptake.[38,40,41] Perceptions of social and professional support regarding immunization behavior[38]

and religious and cultural beliefs[39] further play a role in immunization uptake. Individuals may also be hesitant regarding immunization and therefore choose to refuse some immunizations, delay immunizations, or accept immunizations with uncertainty.[38]

Concern regarding safety and side effects of immunization has been found to be negatively associated with immunization uptake.[36,39–42] Specific parental beliefs that immune overload can occur[41] and that children are receiving too many needles are two examples.[36,41,42] Additionally, some literature suggests parental concern regarding vaccines with multiple antigens affects immunization uptake.[39]

Sociodemographic factors are also associated with immunization coverage. Two systematic reviews found that level of income/socioeconomic status was a significant factor in the uptake of immunizations.[38,41] Families experiencing low socioeconomic status are affected in their ability to access health care due to both biological and social implications of their economic status.[28] Level of parental education was found to have mixed relationships to immunization uptake in one systematic review,[38] while another found lower parental education to be associated with lower immunization uptake.[41]

Furthermore, certain household characteristics have been associated with incomplete immunizations including a large number of children in the family and multiple household moves.[26,28,42] While one study found that young maternal age and single marital status were associated with incomplete immunization coverage,[26] another found no statistical difference in immunization coverage for these groups.[42] This indicates the need for further research surrounding these characteristics and their association with immunization uptake. Additionally, families at risk for under-immunization have been identified as those with teenage parents, children with chronic health conditions, immigrant families, families with a history of domestic

violence, involvement with child welfare, social isolation, and families with greater than three children.[28] In spite of these identified variances of immunization coverage, limited research exists on successful strategies that lead to improved immunization coverage.[28] Lower immunization coverage in populations, such as children in care, disadvantage these children, as it puts them at higher risk to diseases and illness that are potentially preventable.[19]

Children in Care of the Government

Synthesizing information and literature nationally regarding the children in care population is not an easy task because, within Canada, child welfare is under the jurisdiction of provincial and territorial authorities.[43] This challenge is further compounded as variations exist among provinces as to the age at which children are eligible for welfare intervention services, the length of time they can receive these services, and at the most basic level – what the definition of "out-of-home care" encompasses.[43]

In Alberta, child welfare intervention occurs when parents or guardians cannot ensure the safety or well-being of their children.[2] Whenever possible, services are provided to the children in their family home. However, sometimes this is not possible and the children need to be removed from the home either by court order or agreement of the parents or guardians.[2] When children are removed from the home, the most common placement types for children in care in Alberta are foster care (52%) and kinship care (25%).[44] Foster care is a temporary arrangement, where the child is placed in the home of a family with whom the child may not have had a previous relationship. Kinship care is when the child is placed with an extended family member, or with someone with whom they have had a relationship.[45] In both circumstances, the caregivers receive training, support, and financial compensation.[45]

In 2013, there were an estimated 62,400 children in care across Canadian provinces.[7] Prior to 2003, the number of children in care was increasing steadily.[43] Between 2003 and 2013 the number of children in care rose a small amount peaking in 2009 before decreasing to 2003 levels.[43] This report was specific to those in care and did not include children receiving child welfare interventions who remained in their family home. In 2013 there were 12,000 children receiving child welfare interventions in Alberta, with just under 8,500 of these children in care.[8]

In Alberta, Aboriginal children represent a large portion of children receiving child welfare interventions, making up approximately 58% of those receiving any kind of service and 69% of those in care.[2] Aboriginal children are over-represented in child welfare; they account for 69% of children in care in Alberta, yet only make up approximately 10% of the child population in the province.[46] Child welfare for Aboriginal children in Alberta is offered by two authorities, the Delegated First Nation Agency (DFNA) for First Nation people living on-reserve, and the Child and Family Services Authority (CFSA) that serves geographical regions and those children not living on reserves.[8]

Health needs of children in care. It is well known that children in care have high health care needs and have higher health care needs relative to those children not in care.[47] This finding is reinforced by research from various countries including Sweden,[22] the United Kingdom,[48] Australia[10] and the United States.[9,49] Specifically, children in care have been found to have high levels of physical, behavioral, developmental, and emotional health needs.[9–11,49–51] Furthermore, this population utilizes preventive services, such as dental visits, at low rates.[13–15,24,48] This high level of health care need was found to exist in children who experience child welfare intervention regardless of placement type.[11,51] Children who were in foster care at some point in

time during their first 16 years have also been found to have greater exposure to health risks during preschool years including lower breastfeeding rates and higher parental smoking rates.[14]

It is interesting to note that statutory assessments (i.e. required health assessments) in this population are not synonymous with improved health outcomes. Croft suggested that an increase in statutory assessments may give false reassurances that recommendations were being followed and children were receiving necessary health services.[52] They found that almost half of recommendations had not been implemented, which is similar to a 2003 study where 51% of recommendations received follow up action.[24]

Several contributing factors have been identified as playing a role in the high health care needs and poor health care system utilization for children in care. First, there are systematic problems that contribute to a reduction in equitable access to health care for children in care.[12] Such problems include frequent changes of care-givers,[12,17] high caseworker turnover,[12] poor record keeping,[12,16] and lack of knowledge regarding service provision.[12] Additional problems include poor sharing of information between stakeholders, including social services, education, and health care personnel.[48] Researchers have called for better communication, collaboration, and coordination to facilitate better health for children in care.[12,53]

A second set of factors that contributes to high health care needs in this population are the conditions that children are subject to prior to entering government care. Studies have found that upon initial assessment at the time of being removed from their parental homes, these children's health needs were already high.[12,22,51] One study attributed high unmet health needs to neglect and a mobile lifestyle that occurred when children were still in their parental homes, which continued once they were removed from their homes.[16] This research indicates that the

environment of the child prior to being removed from the home contributes to their greater health care needs.

In contrast to these studies, Kufeldt, Simard, and Vachon[54,p.129] found that Canadian children in care "appeared to enjoy better health than the literature would lead us to believe". This report identified that the health of children in care was very similar to that of the comparison group.[54] Indicators used to support their conclusion include: being considered normally well, having special health needs, being exposed to a balanced and healthy diet, and getting regular exercise.

Immunizations and Children in Care of the Government

Routine immunization coverage of children in care of the government has been studied in the United Kingdom, Australia, the United States, Sweden, and Italy. Each country is unique in its provision of social service and immunization delivery, so results of this literature review will be presented by country.

United Kingdom. In the United Kingdom, numerous studies report that children in care, or 'looked after children', as they are referred to in the United Kingdom, are significantly less likely to be fully immunized than the general population.[13,15,17–19,48,55] It has been suggested that lack of immunizations may reflect neglect prior to entering the public care system.[17] However, one study specifically looked at children who had been in care of the government for at least six months and compared their immunization rates to matched controls living at home.[19] Though these children had time to access services once removed from their homes, they were still significantly less likely to be immunized than their matched controls.[19]

Other research followed children in care with outstanding immunizations over a six-month period. At the end of the six month period, 22 of 38 identified children had still not been

immunized, or their immunization status could not be identified.[52] Due to the "appallingly low uptake of 'catch-up' immunizations" this setting now refers children to a 'children in care nurse advisor'.[52,p.80] One study assessed if providing social services information and advice on immunization would improve immunization rates of children in care.[18] With only 53% of children in care having received all recommended immunizations compared to the 90% of children in the district, this intervention still did not result in any of the children in care becoming up to date with their immunizations.[18] The failure of this initiative was attributed to changing social workers, children moving, and discontinuity in both schooling and primary medical care.[18] In one study where immunization coverage for diphtheria, tetanus, pertussis, and polio at age one was assessed, only 67.4% of children in care were up to date versus the national coverage rate of 92%.[15] The author suggests that this may be due to lost health records, lack of understanding of the immunization schedule by social workers, and lack of consistency among computerized records between authorities.[15] An intervention to improve immunization rates in this populations was studied, and by using a specialist nursing service (i.e. a nursing team providing support such as mapping service provision, health promotion advice to social services, and acting as a liaison between health care providers and social services) immunization rates increased from nine to 56%.[56]

In contrast to the majority of studies, two government reports published that the majority of children in care (98%) are up to date on their immunizations.[57,58] These children were in care at least twelve months continuously and the immunization status was reported by social service providers. Another study looking specifically at those children being considered for adoption found adequate coverage rates with only 4.3% requiring immunizations.[59]

Australia. Research regarding immunizations among children in care in Australia showed results similar to studies completed in the United Kingdom. There was significantly lower immunization coverage among children in care as compared to the general population.[23] Australian studies found that 25-50% of children in care were incomplete in their immunizations.[10,51,60,61] In one case, in addition to the 24% of children with incomplete immunizations, a further 14% had no record of their immunization status.[10] Missing records for this population was an issue identified by other researchers.[23]

United States. In the United States, many studies focused on specific groups of children in care, as opposed to broad coverage as assessed in Australia and the United Kingdom. One study found that at three and seven months of age, children who were under immunized were more likely to have confirmed maltreatment than children with up to date immunizations, even after controlling for other factors affecting immunization rates, such as race/ethnicity and insurance status.[62] Another study found that children were less likely to have started their immunization series by three months of age if in foster or sub-adoptive care.[21] A study that looked at a unique group of children in care identified that shelter-based youth (i.e. those residing in emergency shelters) have worse health care access than foster care youth who were not shelter-based.[50]

Studies that did look at broad coverage levels found different results than other countries. One study[63] found that most children were up to date with immunizations (96.9%), however, the immunization status of the child was based on caregiver report, which has been known to overestimate coverage.[64] Two other studies also used a caregiver report immunization data source when comparing immunization coverage of subgroups of children in care and also found high rates of coverage.[65,66] A study completed in the state of Illinois found that coverage was

higher for children in care than in the general population (86-90% of children in foster care vs. 72-75% in state).[67] However, this state specifically was studying the effects of a specialized medical home model for children in foster care to improve coordination and collaboration in their health care provision, and this study found that model to be effective.

Sweden and Italy. Lower immunization rates among children in care of the government are also seen in other countries. A study in Sweden found that 87% of children in foster care were fully immunized, as compared to 97% of the control group.[14] In Italy, children in foster homes had significantly lower immunization rates relative to the general population.[5] Lack of immunization records is an issue noted, with 17% of children in care not having medical records relative to 100% of the general population control group having medical records.[5]

Conclusion

Low immunization coverage was identified among children in care, and when this coverage was compared to children not in care, the majority of studies found lower coverage among children in care. Those studies that did find high or higher coverage used less reliable data sources (e.g. self/caregiver report[63,65,66]) or were the result of a specific intervention aimed at improving immunization coverage.[67] In addition, two trends emerged in this literature review. The first is that immunization coverage in this population decreased as age of the child in care increased.[13,17,22,23,68] The second is that lack of records is of concern in children in care.[4,5,10]

Framework for Study

The framework chosen to guide this study was the Vulnerable Populations Conceptual Model for Research and Practice (See Figure 1).[69] This framework suggests that resource availability, risk factors, and health status are related.[69] The first relationship proposes that lack of resources increases risk of poor health, the second relationship suggests that increased risk

factor exposure affects health status by increasing morbidity and mortality, and the third suggests that decreased health status can lead to a decrease in resource availability.[69] Nursing research, practice, and ethical and policy analysis fits into this conceptualization, as they have the ability to affect resource availability, risk factors, and health status, as well as the relationships among these three areas.[69] This framework is based on the argument that a community health perspective is required to conceptualize vulnerable populations for nursing research, practice, and ethical and policy analysis and that the responsibility to achieve and maintain health lies within the community.[69] This framework fits this study, as the research question that was answered determined whether children in care (a vulnerable group) had a different immunization coverage (health status) when compared to children not in care (risk factor).

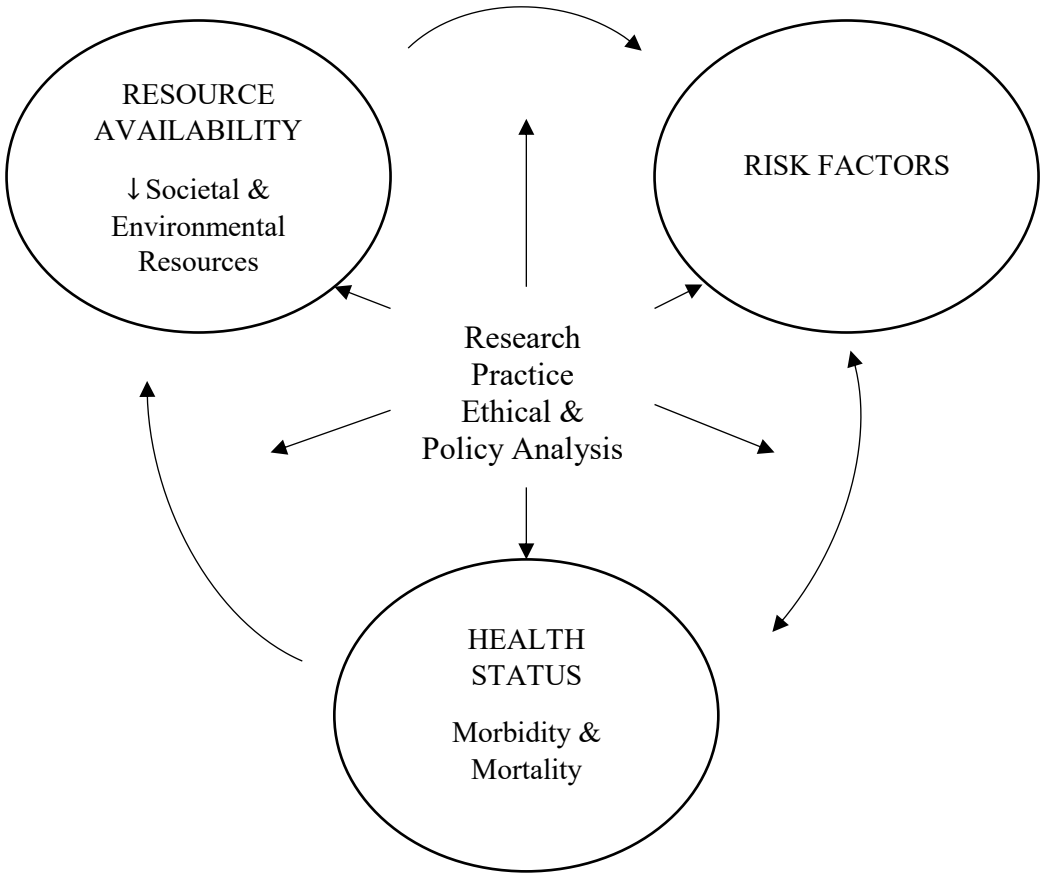

Figure 1. Adapted from Flaskerud & Winslow's "Vulnerable Populations Conceptual Model for Research and Practice"[69]

Design

This was a retrospective birth cohort study analyzing public health and administrative data. The Ministry of Health, Government of Alberta, provided the data for analysis.

Methods

Setting

This study took place in the Canadian province of Alberta, which has a population of 4.25 million,[70] and an estimated average 58,000 births in each of 2015 and 2016.[71] A universal publicly funded health care insurance plan covers routine childhood immunizations in the province.[26] All publicly funded childhood vaccines are administered by public health nurses.[72] Immunizations from birth through preschool are routinely provided at the public health centres and immunizations for school age children are primarily provided in schools. Immunizations administered are recorded in regional immunization databases, then sent to Alberta's provincial Immunization and Adverse Reaction to Immunization database (ImmARI).[26]

Table 1 lists current routine vaccines recommended for children in Alberta.[73] During the duration of this study (2008-2015), varicella and pneumococcal vaccine recommendations changed and rotavirus vaccine was not provincially funded. Therefore, these vaccines were not considered for analysis. At the time of the study, three doses of meningococcal vaccine were recommended (two months, four months, and twelve months).

Table 1. Alberta's routine immunization schedule[1]	
2 months	DTaP-IPV-Hib[2] Pneumococcal conjugate (PCV13) Rotavirus
4 months	DTaP-IPV-Hib Pneumococcal conjugate (PCV13) Meningococcal conjugate (Men-C) Rotavirus
6 months	DTaP-IPV-Hib Pneumococcal conjugate (PCV13) (for high risk children only)
6 months and older	Influenza[3]
12 months	MMRV[4] Meningococcal conjugate (Men-C) Pneumococcal conjugate (PCV13)
18 months	DTaP-IPV-Hib
4-6 year	dTaP-IPV MMRV
Grade 5	Hepatitis B (3 doses) HPV (3 doses)
Grade 9	dTap Meningococcal conjugate (Groups A, C, W-135, and Y) HPV (3 doses – catch up program for boys)
[1] Effective as of June 1, 2015. This table is publicly available on the Government of Alberta website[72] [2] Diphtheria, tetanus, acellular pertussis, polio, *haemophilus influenzae* type b [3] Annually during flu season [4] Measles, mumps, rubella, varicella	

The immunizations assessed in the study represent different dose scheduling, which may shed light on specific challenges of vaccine delivery. Diphtheria, tetanus, acellular pertussis, polio, *haemophilus influenzae* type b (DTaP-IPV-Hib) showed coverage for a multi-dose vaccine, as four doses are required by age two. Meningococcal conjugate (Men-C) showed coverage for a multi-dose vaccine that required fewer doses than DTaP-IPV-Hib, as three doses were required by age two. MMR showed coverage for a single-dose vaccine, as only one dose is required by age two. This provided the opportunity to see if there was a difference in coverage between single and multi-dose vaccines.

Data Sources

Three data sources were used for this study: the ImmARI database, the Vital Statistics database and the Alberta Health Care Insurance Plan Central Stakeholder Registry (AHCIP/CSR) database. The ImmARI database was used to identify immunization status which includes data on specific vaccines administered to all children residents in Alberta, with two exceptions. These exceptions are First Nations children living on reserves who receive their vaccinations through federally administered programs and children in the border town of Lloydminster who receive public health services from the province of Saskatchewan. This database has data submission guidelines and rules that encourage the completeness and quality of data.[26]

It is legislatively required that every live birth in Alberta be reported to Vital Statistics. The Vital Statistics database was used to identify births during the study period, and to extract sex, maternal marital status, maternal age, and mother's number of live births. This information was provided at the time of birth of the child in the 2008 birth cohort.

The AHCIP/CSR database was used to identify First Nations status, deaths, departure from province, non-Alberta residents, postal codes (to determine number of household moves), and children in care. More than 99% of the population are covered by the Alberta Health Care Insurance Plan and therefore are in the AHCIP/CSR database.[26] Care information includes first and last care date (to the nearest annual quarter). Duration of time in care is not available in this database. An identifier is noted in the database when a new Alberta Health Care card is applied for by a caregiver for a child who is in care. If a child has this identifier at any time from birth up to the age of analysis (age two and seven) they were considered in care. A known limitation of this identifier from AHCIP/CSR is that it does not encompass all children in care, as it only

identifies a subset of children in care (i.e. those whose caregivers applied for a new Alberta Health Care card). Relevant information from the AHCIP/CSR, ImmARI and Vital Statistics databases were linked, and a dataset of the birth cohort was created by staff at the Ministry of Health.

Study Population and Identification of Cohort

After exclusion criteria were applied, the study population was a 2008 Alberta birth cohort of 44,206 children (age two analysis) and 42,241 children (age seven analysis). The cohorts at age two and seven were comprised of non-First Nations children born in Alberta in 2008, who were not born in or did not live in Lloydminster, and who remained in the province and were living at the age of assessment. This cohort has been previously studied at age two for conditions associated with partial immunizations.[26]

Measures

Care status (independent variable). This variable was determined using data from the AHCIP/CSR database. A child was identified as being in care or not in care based on whether they had a 'first date of care' identifier. Children were categorized as being in care if they had the identifier attached to their file at any period of time from birth to the age of analysis. For example, a child who had a first care date at age three would be categorized as in care at age seven, but not age two, as the child was first taken into care after the age of first analysis. A child who had their first care date prior to age two would be included in analysis at age two and seven. The duration of time in care and current care status at age of analysis was not available.

Competing household demands (independent variable). This variable was determined using data from the Vital Statistics and AHCIP/CSR databases. This variable was a composite variable of four factors: maternal marital status, maternal number of live deliveries, maternal age

(at time of child's birth), and number of household moves by age two. Following the methodology used by Bell et al.,[26] (i.e. using natural cut points in coverage for each factor) the following were considered to be a competing household demand: single marital status, mother having four or more live deliveries, a maternal age of 25 and under, and multiple household moves were two or more by age two. The first three factors were assessed at the time of birth of the child in the study cohort.

Immunization coverage (dependent variable). Immunization coverage is the number of children who received the scheduled number of vaccines (numerator) relative to the total number of children eligible for the scheduled number of vaccines described (denominator). Coverage was presented as a proportion and percentage. Although a child who is delayed in their immunizations may require fewer doses than the recommended schedule, this was not adjusted for in analysis. A child was considered complete in immunization at age two if they had received four doses of DTaP-IPV-Hib, three doses of Men-C, and one dose of MMR, and at age seven if they had received five doses of DTaP-IPV/dTaP-IPV and two doses of MMR.

Immunization coverage at age two. Immunization status classification for DTaP-IPV-Hib, Men-C, and MMR were assessed on the child's second birthday. A summed variable was created for each vaccine. If a child received four or more DTaP-IPV-Hib vaccines before 24 months they were coded as "up-to-date". If a child received three or more Men-C vaccines before 24 months they were coded as "up-to-date". If a child received one MMR vaccine after 11 months and before 24 months they were coded as "up-to-date". If a child had not received the required number of doses for that vaccine they were coded as "not up-to-date". Doses of MMR given before 12 months are not valid and does not contribute to lifelong immunity. Thus, any

doses administered at less than 12 months were not considered when summing number of doses of MMR containing vaccine.

Immunization coverage at age seven. Immunization status classification for DTaP-IPV/dTaP-IPV and MMR were assessed on the child's seventh birthday. The methodology for calculating doses at age seven was the same as for age two. A summed variable was created with the number of vaccines given before 84 months for each vaccine. If a child received five or more DTaP-IPV/dTaP-IPV containing vaccines before 84 months they were coded as "up-to-date". If a child received two MMR vaccines after 11 months and before 84 months they were coded as "up-to-date". If a child had not received the required number of doses for that vaccine they were coded as "not up-to-date".

Analysis

The dataset was provided by the Ministry of Health and SPSS 24.0[74] was used carry out statistical analysis. Descriptive statistics were completed to assess the characteristics of the two groups: children in care and children not in care. The variables assessed included: sex, maternal marital status at time of birth, maternal age at time of birth, maternal number of live deliveries at time of birth, and number of household moves by age two.

Research question one: What is the immunization coverage for children in care of the government in Alberta? As described previously, care status and immunization status variables at age two and age seven were created. To determine coverage, the cross-tabs function was used to perform a frequency analysis. The variables for up-to-date status at age two and seven for DTaP-IPV-Hib/DTaP-IPV and MMR were the dependent variable and care status was the independent variable. Frequency of children in care being up to date relative to the overall population was presented as a proportion.

Research question two: Is there a difference in the immunization coverage for children in care of the government and children not in care of the government in Alberta? Chi square tests with 95% confidence intervals were performed to compare coverage of children in care and not in care. For each immunization at age two and seven, confidence intervals were calculated using an online calculator.[75] The binary/categorical independent variable was care status and the binary/categorical dependent variable was immunization coverage. No assumptions were violated (i.e. all cells had a count higher than five) and a p-value of less than 0.05 was considered significant. A logistic regression was performed to determine the odds ratios of immunization coverage for children in care, compared to children not in care.

Research question three: Is there a difference in the immunization coverage in Alberta for children in care, children not in care with competing household demands, and children not in care from a household with no competing demands? For each vaccine at age two and seven, a chi squared test with 95% confidence intervals was performed to compare immunization coverage between children in care, children not in care from households with competing demands, and children not in care without competing demands. The independent categorical variable was care status (children in care, children not in care with competing household demands, and children not in care with no competing demands). The dependent variable was immunization coverage. No assumptions were violated and a p-value of less than 0.05 was considered significant. A logistic regression was performed to determine the odds ratios and confidence intervals of immunization coverage for children in care compared to children not in care with no household demands, and children not in care with competing household demands.

Due to a small sample size of children in care at age two (n=129) and seven (n=213), it was not possible to control for factors that have been previously associated with lower

immunization coverage, including the previously described competing household demands. However, the logistic regression results provided insight into the size of effect of the association.

Summary

Children in care are at-risk for under-immunization and associated risks. Therefore, it is important to establish the immunization coverage of children in care in Alberta and how this compares to children not in care to identify if further action and advocacy are required to promote health in a vulnerable population. The Vulnerable Populations Conceptual Model for Research and Practice[69] guided this retrospective cohort study. Results are described in the manuscript found in Chapter II, with further overview of results discussed in Chapter III.

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Chapter II: Manuscript as prepared for submission to *Pediatrics*

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Vaccination Coverage of Children in the Child Welfare System

Abstract

Background: Children in care of the child welfare system ('children in care') are a vulnerable population who access preventive health services less than children not in care.

Objective: To assess vaccine coverage of a cohort of children in care in Canada and compare it to children who have never been in care.

Methods: Three population-based administrative datasets were linked to assess vaccine coverage for children at age two (N=44 206) and seven (N=42 241) for diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae type b* (DTaP-IPV-Hib), meningococcal (Men-C), and measles, mumps, rubella (MMR) vaccines. A child was considered to be in care if they spent any time in care before the age of assessment. Logistic regression was used to compare vaccination status.

Results: Vaccination coverage for children in care at age two ranged from 54.3% (DTaP-IPV-Hib) to 81.4% (MMR) compared to those not in care which ranged from 74.2% (DTaP-IPV-Hib) to 87.4% (MMR). Coverage for children in care at age seven was 53.1% (DTaP-IPV) and 65.3% (MMR) compared to those not in care 76.6% (DTaP-IPV) and 83.4% (MMR). For both ages, the odds of being under vaccinated were higher for children in care for all vaccines (e.g. DTaP-IPV-Hib odds ratio [OR]: 2.43; 95% confidence interval [CI]: 1.72-3.44). For children not in care that live in households with competing demands (e.g. highly mobile lifestyle), their coverage was lower (e.g. 63.1% for DTaP-IPV-Hib) than those not in care without such demands (e.g. 76.4% for DTaP-IPV-Hib) but higher than children in care. Among the three groups, children in care had the highest odds of being under vaccinated (e.g. DTaP-IPV-Hib, OR: 2.72; 95% CI: 1.93-3.86).

Conclusion: Children in care have lower vaccine coverage than children not in care. Policies and practices should be examined to ensure optimal access to vaccination for these children.

What's Known on This Subject

Children in the child welfare system ('children in care') are a vulnerable population. Vaccination is a critical preventive health care measure, yet, preventive health service access is lower among children in care.

What This Study Adds

Using population-based data sources, children in care were found to have lower vaccination coverage than children not in care. This is the first Canadian study to assess this issue.

Introduction

Vaccination is considered to be one of the greatest public health interventions in the last century.[1] In spite of the effectiveness of vaccination, disparities in vaccination coverage exist,[2] and vulnerable populations continue to be at risk from vaccine preventable disease. One population of concern is children in the child welfare system (e.g. foster care, kinship-care, and group homes), known as children 'in care'. Children in care have higher health needs than children not in care,[3] yet access preventive services less than those not in care.[4] Identified barriers for these children in accessing preventive services include: poor collaboration and coordination between child service providers,[5] high caseworker turnover,[6] neglect, and mobile lifestyle prior to being taken into care.[7]

Measurement of vaccination coverage is important when identifying herd immunity and as a performance indicator for programs and policies.[8,9] This is particularly true for vulnerable populations, such as children in care, in order to minimize already existing health disparities. Yet, limited knowledge exists on whether these children are adequately vaccinated. Population-

based studies in the United States, that assessed immunization coverage of children in care did not assess children beyond three months of age[10] or assessed coverage in a population that received health care from a targeted intervention rather than routine health services.[11] The purpose of this study was to assess vaccination coverage of a Canadian birth cohort of children in care at age two and seven. Using population-based public health and administrative databases, vaccination coverage for children in care was compared to children not in care. We also assessed the impact that certain household factors associated with lower vaccination coverage (i.e. single marital status, young maternal age, multiple children in the home, and multiple household moves) had on vaccination coverage in these groups.

Methods

This study took place in the western Canadian province of Alberta, which has a population of 4.25 million.[12] A universal publicly funded health care insurance plan provides routine recommended childhood and adolescent vaccinations free of charge. For children two months up to preschool age, these are delivered at community health centers by public health nurses, according to the schedule set by the Ministry of Health.[13] This study assessed coverage for the following vaccines: diphtheria, pertussis, tetanus, polio, *Haemophilus influenzae* type b (DTaP-IPV-Hib), meningococcal conjugate (Men-C), and measles, mumps, rubella (MMR). This allowed for the comparison of vaccines with varying numbers of recommended doses (four doses of DTaP-IPV-Hib by age two, with an additional dose of dTaP-IPV by age seven; three doses of Men-C by age two; one dose of MMR by age two with an additional dose by age seven). Vaccination coverage was not assessed for varicella and pneumococcal vaccines, as the recommended schedule changed partway through the study period. Men-C was not assessed at age seven as no doses are due past 12 months of age.

Three data sources were linked for this study: the provincial Immunization and Adverse Reaction to Immunization (ImmARI) repository, Vital Statistics, and the Alberta Health Care Insurance Plan Central Stakeholder Registry (AHCIP/CSR). Vaccination status was obtained from ImmARI which receives individual-level vaccination data for all publicly-funded vaccines administered with two exceptions: First Nations children living on reserves, who receive their vaccinations through federally administered programs, and children in the border town of Lloydminster, who receive public health services from the adjacent province. Vital Statistics provides data on every live birth in the province. It was used to identify the birth cohort and characteristics of participants including sex, maternal marital status, maternal age, and number of children in the household. AHCIP/CSR provides information on 99% of the provincial population, as it tracks enrolment in the provincial health care insurance plan.[14] This database was used to identify First Nations children, deaths, departure from the province, visitors to the province, children in care, and postal code.

The study population was a 2008 birth cohort of 50 149, consisting of all children born in the province from January 1 to December 31, 2008. Those who had First Nation status, lived in the border town of Lloydminster, and who left the province or died before the age of analysis were excluded.

This cohort has been previously studied to identify characteristics of those not receiving the full number of recommended vaccines including: young maternal age, single marital status of mother, mother's number of previous live births, and multiple household moves.[14] All of these characteristics contribute to what we will refer to as 'competing demands' in a household and are similar to characteristics that are often seen in children in care.[15] In this study, we aimed to

determine if vaccination coverage for children in care is different than children who are not in care. For the latter group, we considered both those with and without competing demands.

A child was considered to have 'competing demands' if they came from a household with two or more of the following: (1) two or more household moves by two years of age, (2) maternal age of 25 years or less, (3) mother having four or more live births, and (4) single maternal marital status. The latter three characteristics were assessed at time of birth of the child in the cohort and the cut points for each factor was based on natural break points in the data. A child was identified as being in care when their care provider applied for a new health care card for the child. A child was considered to be in care if they spent any time in care before the age of analysis.

We calculated the proportion of eligible children vaccinated ('coverage') for children in care and children not in care (both with and without competing demands). Chi-square test (χ^2) was used to compare characteristics of children in care and children not in care. Logistic regression was used to identify the magnitude of the association between care status and vaccination coverage, as well as the association between competing demands and vaccination coverage. Statistical analysis was completed using SPSS 24.0.[16] Ethics approval was obtained from the University of Alberta Human Research Ethics Board B.

Results

After exclusions (Figure 1), 44 206 children were in the age two cohort and 42 241 children were in the age seven cohort. In total, there were 292 (0.66%) children in care in the cohort (Table 1), 129 at age two and 213 at age seven. Table 1 describes cohort characteristics comparing children in care and children not in care. There were statistically significant differences in all characteristics that were identified between the two groups.

As seen in Table 2, at age two, vaccine coverage for children in care by individual vaccines ranged from 54.3% (DTaP-IPV-Hib) to 81.4% (MMR). At age seven, coverage was lower for these children, ranging from 53.1% (DTaP-IPV) to 65.3% (MMR). Children in care were found to have significantly lower vaccination coverage than children not in care, at both ages two and seven. At age two, children in care had the greatest odds of being under vaccinated for DTaP-IPV-Hib vaccine (odds ratio [OR] 2.43; 95% confidence interval [CI]: 1.72-3.44) and the smallest odds of incomplete vaccination for MMR vaccine (OR 1.58; 95% CI: 1.02-2.47). At age seven, children in care had the greatest odds of being under vaccinated for DTaP-IPV vaccine (OR 2.90; 95% CI: 2.21-3.80).

The odds of being under vaccinated increased with age for children in care. The odds of a child in care being under vaccinated for MMR compared to a child not in care was higher at age seven (OR 2.67; 95% CI: 2.01-3.54) than age two (OR 1.58; 95% CI: 1.02-2.47). DTaP-IPV vaccine saw a similar increase in the odds of being under vaccinated at age seven (OR 2.90; 95% CI: 2.21-3.80) than DTaP-IPV-Hib vaccine at age two (OR 2.43; 95% CI: 1.72-3.44).

Table 3 compares vaccination coverage between three groups: children in care, those not in care but with competing demands, and those not in care without competing demands. At both age two and seven, children not in care without competing demands saw the highest vaccine coverage for all vaccines (e.g. 76.4% DTaP-IPV-Hib at age two), followed by children not in care with competing demands (e.g. 63.1% DTaP-IPV-Hib at age two). Children in care had the lowest coverage (e.g. 54.3% DTaP-IPV-Hib at age two).

At age two, compared to children not in care without competing demands, children in care had higher odds of being under vaccinated for DTaP-IPV-Hib vaccine (OR 2.72; 95% CI: 1.93-3.86) than children not in care with competing demands (OR 1.89; 95% CI: 1.79-2.00)

(Table 4). Though the odds were smaller, children in care also had the highest odds of being under vaccinated for both Men-C and MMR vaccines (OR 2.25; 95% CI:1.51-3.34 and OR 1.72; 95% CI: 1.10-2.69 respectively). At age seven, when compared to children not in care with no competing demands, children in care had higher odds (OR 3.25; 95% CI: 2.48-4.26) to be under vaccinated for DTaP-IPV than children not in care with competing household demands (OR 1.91; 95% CI: 1.81-2.03). Among the three groups at age seven, children in care also had the highest odds of being under vaccinated for MMR (OR 2.97; 95% CI: 2.24-3.95).

Discussion

This is the first study to assess the vaccination coverage of children in care in Canada.[17] The use of a province-wide population-based immunization database ensured the assessment of coverage is complete and comprehensive.

Vaccination coverage by care status

Children in care were found to have lower vaccination coverage than children who had never been in care. Our findings reflect the published literature that there is lower vaccine coverage among children in care compared to the general population. Studies from the United States,[10,18] the United Kingdom,[4,19] Italy,[20] and Sweden[21] found lower vaccine coverage for children in care compared to children not in care or the general population. The two studies from the United States focused on specific groups and early ages. One found children with confirmed maltreatment to have lower vaccination coverage than those without.[22] The other found children in foster care were less likely to initiate vaccination by three months than children in Medicaid.[10]

In contrast, two studies from the United States have found adequate and/or higher vaccination among children in care.[11,23] One found over 96% of children in care are fully vaccinated.[23] However, this study used self/caregiver source for vaccination status, a method that

can over estimate vaccine coverage.[24] Another found children in care had higher vaccination coverage than the general population, but the authors credited the higher rates to the implementation of a Medical Home model for children in care.[11]

Vaccination coverage by competing demands

Literature indicates that children with competing demands and children in care are both at greater risk for incomplete vaccination.[14,20,21,25] In addition, children in care have been identified as coming from households with competing demands.[15] This was found to be true in our study, as 95.2% (278/292) of children in care had one or more competing demands. In order to determine if these competing demands were solely responsible for the lower vaccination coverage in children in care, we compared coverage of children in care to children not in care who also had competing demands. Although children not in care with competing demands had higher odds of being under vaccinated compared to those with no competing demands, children in care had even higher odds of being under vaccinated. It is therefore likely that competing demands may partially, but not completely, explain the lower vaccine coverage for children in care.

Factors affecting vaccination among children in care

In this study, we identified two trends in vaccination among children in care. First, the higher the number of vaccine doses that were required to be fully immunized, the more likely children in care were to be under vaccinated. Second, consistent with previous studies,[9,26] we found that the odds of children in care being under vaccinated increased with age.

Literature suggests some possible contributors to the low vaccine coverage we found among children in care. A lack of coordination and information sharing between health and social services, and discontinuity of care, are identified gaps in service provision for children in

care which may lead to lower vaccine coverage and poor recording of vaccinations.[26–28] These issues may contribute to low vaccine coverage, as both social services and health service providers may be unaware of required vaccinations and current contact information. Vaccinating these children could be seen as someone else's responsibility, thus affecting interagency collaboration.[28]

Based on anecdotal reports from clinicians in our study setting, the lower coverage we observed in children in care may partially be explained by difficulties in obtaining informed consent to proceed with vaccination for children in care. Depending on the type of child welfare intervention, the foster parent may not have delegation to offer informed consent and the biological parent or the court appointed guardian may need to be reached before proceeding with vaccination.

Strengths and limitations

Our study was population-based with vaccination data from a provincial administrative dataset that accounts for all childhood vaccines given within the province. The one exception is First Nations children, limiting generalizability to that population, which comprise 69% of children in care in the province.[29]

One limitation of our study was that the AHCIP/CSR database did not indicate duration of time a child was in care, present care status, or children in care whose caregivers had not applied for a new health care card. Therefore, we were unable to differentiate between vaccination coverage before, during, and after the child welfare intervention. Second, our small sample size of children in care prohibited us from controlling for various confounding factors, such as competing demands within the children in care group.

Recommendations

Further research can assess if time in care impacts vaccination status, as existing social service policies in the study setting indicate that children in care should be vaccinated. Other research of value would include studying: (1) timeliness of vaccines among children in care, (2) vaccination coverage with a sample size large enough to control for confounding factors, and (3) barriers and supports to vaccination in this group.

Policies and procedures should be reviewed to ensure that children in care have minimal barriers in accessing vaccination and preventive health care. However, policies and information alone are not effective to improve vaccination coverage of children in care. As was found in a previous small study of 54 children, providing information to social services on children's vaccination needs did not improve vaccine coverage.[19]

Targeted resources and strategies are needed to address vaccination coverage among children in care. Improved vaccination coverage of children in care can be achieved through coordinated and integrated care between social services and health, as seen in studies of a Medical Home model and a specialized nursing service.[11,28] In both circumstances, there was a group that took on the role of the child's advocate, either the nursing service or the Medical Home, who saw it as their responsibility to ensure coordination, collaboration, and continuity of care in health provision for the children.[11,28] As children in care face many challenges, including discontinuity in care and a system where their health care needs may be viewed as someone else's concern,[28] it is imperative to target resources to facilitate collaboration and coordination between the service providers. This is a health equity issue that should not be ignored. If the vaccination coverage of children in care is inadequate in a publicly funded health care system

such as Canada, the potential problem may be magnified in a country with a private health care system.

Conclusion

Our study suggests that children who have been in care of the government have lower vaccination coverage compared to children who have never been in care. Using an administrative database that captured nearly all provincially funded childhood vaccines administered in the province, this disparity was found true for DTaP-IPV-Hib, Men-C, and MMR vaccines. Children in care were also more likely to have lower vaccination coverage than children not in care with competing demands.

It is crucial that action be taken to ensure these vulnerable children have full access to preventive health services. This includes further research to understand the causes of low vaccination coverage, effective interventions to improve coverage, and efforts to improve interagency collaboration.

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Figure 1. Cohort identification

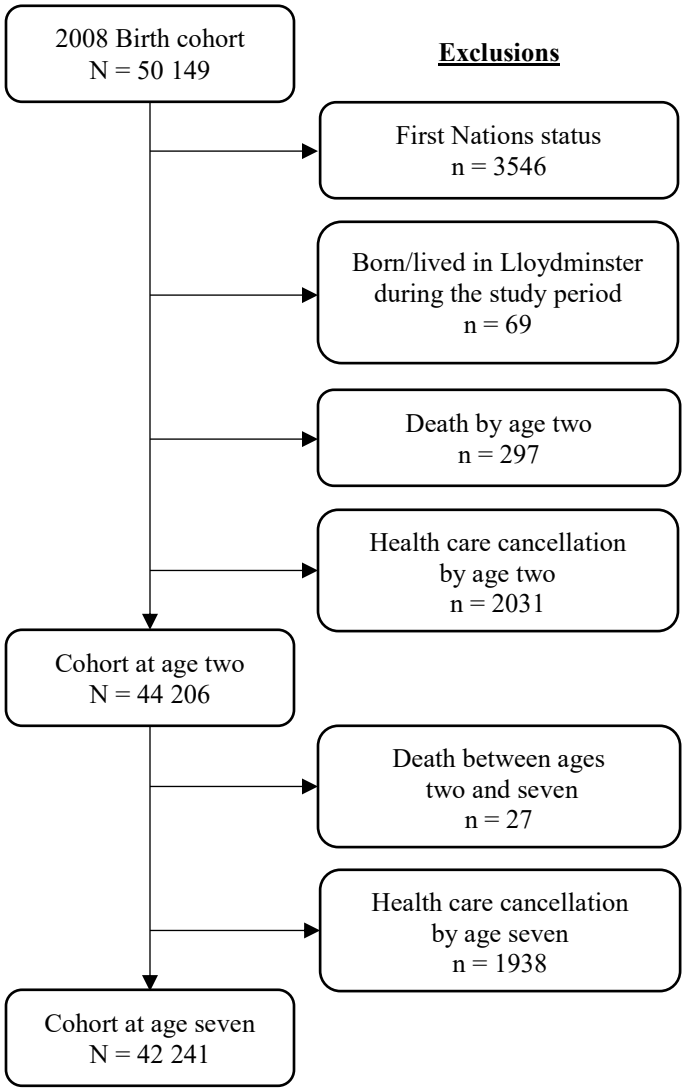

Table 1. Characteristics of children in care and children not in care

Characteristics	Children in care (n=292; 0.66%), n (%)	Children not in care (n=43 914; 99.3%) n (%)	p-value for comparison
Sex			.953
Male	151 (51.7)	22 633 (51.5)	
Female	141 (48.3)	21 281 (48.5)	
Maternal marital status[a]			<.001
Single	247 (84.6)	10 909 (24.8)	
Not single	45 (15.4)	33 005 (75.2)	
Maternal # of live births[a,b]			<.001
≤3	235 (80.5)	40 591 (92.4)	
≥4	57 (19.5)	3323 (7.6)	
Maternal age[a]			<.001
≤25	182 (62.3)	11 117 (25.3)	
≥26	110 (37.7)	32 797 (74.7)	
# of moves by age 2			<.001
≤1	203 (69.5)	42 131 (95.9)	
≥2	89 (30.5)	1783 (4.1)	
Total # of competing demands[c]			<.001
0	14 (4.8)	24 612 (56.0)	
1	54 (18.5)	12 358 (28.1)	
2	156 (53.4)	6075 (13.8)	
3	63 (21.6)	852 (1.9)	
4	5 (1.7)	17 (0.0)	

Abbreviation: #, number.
[a] At time of child's birth.
[b] Includes index child.
[c] Competing demands are marital status is single, maternal # of live births ≤3, maternal age ≤25, household moves by age two ≥2.

Table 2. Children who have received all recommended vaccine doses at age two and seven, by care status.

	Children not in care No., % (95% CI[a])	Children in care No., % (95% CI[a])	OR of NOT having full number of vaccine doses[b] OR (95% CI)
Age Two			
	n = 44 077	n = 129	
DTaP-IPV-Hib (4 doses)	32 724, 74.2% (73.8-74.7)	70, 54.3% (45.7-62.9)	2.43 (1.72-3.44)
Men-C (3 doses)	37 731, 85.6% (85.3-85.9)	96, 74.4% (66.9-81.9)	2.04 (1.38-3.04)
MMR (1 dose)	38 513, 87.4% (87.1-87.7)	105, 81.4% (74.7-88.1)	1.58 (1.02-2.47)
Age Seven			
	n = 42 028	n = 213	
DTaP-IPV (5 doses)	32 199, 76.6 % (76.2-77.0)	113, 53.1% (46.3-59.8)	2.90 (2.21-3.80)
MMR (2 doses)	35 041, 83.4% (83.0-83.7)	139, 65.3% (58.9-71.7)	2.67 (2.01-3.54)

Abbreviations: No., number; CI, confidence interval; OR, odds ratio; DTaP-IPV-Hib. diphtheria, tetanus, pertussis, polio, *haemophilus influenzae* tybe b; Men-C, Meningococcal; MMR, measles, mumps, rubella; DTaP-IPV. diphtheria, tetanus, pertussis, polio.

[a] Calculated using online calculator (http://www.sample-size.net/confidence-interval-proportion/)

[b] Reference group = children not in care, comparison group = children in care.

Table 3. Children who have received all recommended vaccine doses at age two and seven, by competing demands and care status.

	Children not in care with no competing demands[a] No., % (95% CI[b])	Children not in care with competing demands No., % (95% CI)	Children in care No., % (95% CI)
Age Two			
	n = 37 010	n = 7067	n = 129
DTaP-IPV-Hib (4 doses)	28 265, 76.4% (75.9-76.8)	4459, 63.1% (62.0-64.2)	70, 54.3% (45.7-62.9)
Men-C (3 doses)	32 099, 86.7% (86.4-87.1)	5632, 79.7% (78.8-80.6)	96, 74.4% (66.9-81.9)
MMR (1 dose)	32 671, 88.3% (87.9-88.6)	5842, 82.7% (81.8-83.5)	105, 81.4% (74.7-88.1)
Age Seven			
	n = 35 542	n = 6486	n = 213
DTaP-IPV (5 doses)	27 934, 78.6% (78.2-79.0)	4265, 65.8% (64.6-66.9)	113, 53.1% (46.3-59.8)
MMR (2 doses)	30 146, 84.8% (84.4-85.2)	4895, 75.5% (74.4-76.5)	139, 65.3 (58.9-71.7)

Abbreviations: No., number; CI, confidence interval; DTaP-IPV-Hib. diphtheria, tetanus, pertussis, polio, *haemophilus influenzae* tybe b; Men-C, Meningococcal; MMR, measles, mumps, rubella; DTaP-IPV. diphtheria, tetanus, pertussis, polio.

[a] Competing demands are two or more of the following: maternal marital status is single, maternal # of live births ≤3, maternal age ≤25, household moves by age two ≥2.

[b] Calculated using online calculator (http://www.sample-size.net/confidence-interval-proportion/)

Table 4. Odds ratio (OR) for not receiving all recommended vaccine doses at age two and seven, by competing demands and care status.

	Children not in care with no competing demands[a]	Children not in care with competing demands	Children in care
	OR of NOT having all vaccine doses OR (95% CI)	OR of NOT having all vaccine doses OR (95% CI)	OR of NOT having all vaccine doses OR (95% CI)
Age Two			
DTaP-IPV-Hib (4 doses)	reference	1.89 (1.79-2.00)	2.72 (1.93-3.86)
Men-C (3 doses)	reference	1.67 (1.56-1.79)	2.25 (1.51-3.34)
MMR (1 dose)	reference	1.58 (1.47-1.69)	1.72 (1.10-2.69)
Age Seven			
DTaP-IPV (5 doses)	reference	1.91 (1.81-2.03)	3.25 (2.48-4.26)
MMR (2 doses)	reference	1.82 (1.70-1.94)	2.97 (2.24-3.95)

Abbreviations: No., number; CI, confidence interval; OR, odds ratio; DTaP-IPV-Hib. diphtheria, tetanus, pertussis, polio, *haemophilus influenzae* tybe b; Men-C, Meningococcal; MMR, measles, mumps, rubella; DTaP-IPV. diphtheria, tetanus, pertussis, polio.

[a] Competing demands are two or more of the following: maternal marital status is single, maternal # of live births ≤3, maternal age ≤25, household moves by age two ≥2.

Chapter III: Discussion

Introduction

The purpose of this study was to assess immunization coverage of children who have been in care of the government in Alberta and compare this to children who have never been in care. This chapter will briefly review the findings of this study followed by a discussion of its limitations and strengths. Finally, implications and recommendations arising from this research will be described.

Overview of Findings

This study shows that children who have spent time in care of the government have received inadequate immunization and that these children have lower immunization coverage than children who have never been in care. This was statistically significant for all vaccines at both ages two and seven. The likelihood of not having received all immunizations increased as the number of doses of vaccine in the series and age increased. A larger disparity in immunization coverage is noted between children in care and children not in care without multiple competing household demands than when children in care were compared to children not in care with competing household demands.

Study Limitations

Limitations of this study include the data source used to identify that children were in care and the small sample size of children in care. The information available in the ACHIP/CSR database is not comprehensive in capturing all children in care, the duration of care, present care status, or the type of intervention the child is receiving (e.g. still at home, foster care, kinship care, etc.). AHCIP/CSR only indicates, to the nearest annual quarter, when a child received a new health care card after being taken into care. There is also information in the database, to the nearest annual quarter, of the last date of care. With only the first and last care dates to the

nearest annual quarter, it was not possible to determine duration or frequency of care and type of child welfare intervention. Furthermore, not all children in care receive a new health care card, so we are likely underestimating children in care. Future work will be necessary to capture the entire population of children receiving child welfare interventions and to better understand the impact of type of intervention on immunization coverage. This would require collaboration and data linkage between Alberta's Ministry of Children's Services and Ministry of Health.

This study did not include some of the population of Aboriginal children in care as the ImmARI database does not include data on First Nations children living on reserve because their immunizations are delivered by Health Canada. This limits generalizability of the study results, as 69% of children in care in Alberta are Aboriginal.[1]

A further limitation of this study is the small sample size of children in care. As a result, wide confidence intervals were seen, indicating impreciseness of the point estimate. The small sample size of children in care also prevented controlling for cofounding variables in analysis. Future work that addresses collaboration between the Ministry of Health and the Ministry of Children's Services would enable a larger sample size to be used.

This study did not assess timeliness of immunizations. However, this was not the purpose of this study. Future work may assess timeliness of coverage in this population.

Study Strengths

One of the greatest strengths of this study was the comprehensive and accurate indicators used to determine immunization status. As this information was taken from a provincial immunization repository, accurate and complete data on immunizations was captured.

Also, as the cohort was identified through the Vital Statistics database, this population-based study is inclusive of all children regardless of location, income status, and ethnicity (apart

from those with First Nations status), allowing for a broad understanding of the scope of the issue. Based on a systematic review that is nearing completion,[2] this study is the first in Canada to assess immunization coverage among children in care. This study begins to fill an identified gap in research surrounding this vulnerable population.

Implications and Recommendations

This work is significant because it has led to a better understanding of the health status of a vulnerable group, and highlights implications for nursing practice, insight regarding policy, and directions for future research.

The Vulnerable Populations Conceptual Model for Research and Practice[3] that guided the study, and is described in Chapter I, offers direction for understanding the significance of this research. As a difference was found in immunization coverage (health status) based on care status (risk factors), it is important to assess the resource availability in addition to the research, practice, ethics, and policies that are influencing these findings. Flaskerud and Winslow suggest that research on vulnerable populations needs to move beyond descriptive and epidemiological approaches to intervention and outcome studies.[3] This study fits within a larger research program that will continue to evolve based on the findings of this study. Also, this study meets the outcome requirements of the model by objectively measuring health outcomes and health care utilization data of a vulnerable group. These results are a baseline against which intervention effectiveness can be measured at a later date. It is acknowledged that a challenge of this model is the numerous intervening variables. This challenge is seen in this study as there are numerous variables that may account for the disparity in immunization status (e.g. competing household demand variables, number of social workers, number of health care providers). Yet, studies that test population-based interventions (immunizations in the case of this study) are useful to

examine policy related issues and offer a knowledge foundation for health care of vulnerable groups.[3]

Based on the findings of this study, there are actions to be taken to address the issue of low immunization coverage among children who are or have been in care of the government. The nursing profession has a role in addressing this identified concern. This study encompasses several values of the nursing profession: promoting and respecting informed decision making, promoting health and wellbeing, and promoting justice.[4] This research provides a basis for more informed policy decisions to support the health of this population. Specifically, this research identifies an issue and offers a specific achievable target for which nurses should advocate regarding socially vulnerable populations. Children in care have sub-optimal immunization coverage and lower immunization coverage than children not in care. Nurses can advocate to improve this coverage at the patient, service, and policy levels. For example, at the patient level, nurses can educate caregivers to ensure they know the required paperwork (including informed consent), vaccine schedule, and immunization appointment booking process. At the service level, nurses can advocate for flexible appointments for children in care, as the hectic nature of homes of foster caregivers have been identified as a barrier to immunization.[5] At the policy level, nurses can advocate for increased collaboration between Alberta's Ministry of Health and the Ministry of Children's Services to promote maximum information sharing that facilitates immunizations.

Public health nurses must take a leadership role in coordinating and facilitating collaboration between service providers to improve immunization coverage of children in care. One study has found that a specialized nursing service can improve immunization coverage among children in care by acting as a coordinator and facilitator for the child's health needs.[6] The idea of coordination, communication, and support acting as facilitators of immunization

coverage was evident in another study from the United States,[7] where the high immunization rates among children in care was attributed to a Medical Home model. The Medical Home is based on seven guiding principles: accessible, family-centered, continuous, comprehensive, coordinated, compassionate, and culturally compentent.[7] It includes many comprehensive services including early intervention access, primary care, as well as one central comprehensive record for the child that is accessible yet maintains confidentiality.[8] As per the Alberta Academy of Pediatrics 2002 definition, a physician must ensure services are being offered to meet the definition.[8] I suggest that there is potential for the aspects of a service similar to a Medical Home to be directed by Registered Nurses and Nurse Practitioners in collaboration with physicians. The literature review reported on in chapter I highlights the numerous challenges this vulnerable group faces. This can mean that preventive health visits may not be a priority, depending on individual circumstances. Fitting well within their mandate, public health nurses could take a leadership role, replicating principles of the medical home model and the specialized nursing service within Canada. Furthermore, public health nurses can send reminders to caregivers and be flexible in offering appointments. These actions have been identified to improve foster caregiver adherence to appointments.[5] Social workers also have a role to play and can ensure that they have obtained immunization records and informed consent for the child, and that the foster caregiver is aware of required immunizations.

Policies in the Ministry of Health, Ministry of Children's Services, and Alberta Health Services must be reviewed in collaboration to facilitate cohesive care. Consideration should be given to delegating specific responsibilities that will address gaps in provision. Policies can be developed to ensure data sharing and facilitate collaboration among all agencies providing care

for these children. It will be critical to evaluate policies and policy changes to ensure that implementation is occurring, and that no gap exists between policy and practice.

Finally, further research is needed as several questions have arisen from these findings. These questions can be found in the outline of suggested studies below.

Suggested Study I

With a new understanding of the population and data characteristics, preliminary findings from this work could be replicated using more complete data provided by partners (Ministry of Children's Services and First Nations communities). This will provide a more comprehensive analysis on identified disparities in immunization coverage.

Research questions. What is the immunization coverage of all children in care (regardless of type of care)? What is the immunization coverage of children entering care compared to children who have been in care for one year or longer? What is the immunization coverage of children who have been in care for one year compared to children not in care? Is there a difference in immunization coverage after controlling for confounding variables?

Design. Retrospective cohort (combining more than one birth year to create a large cohort).

Data sources. ImmARI, AHCIP/CSR, Vital Statistics, Ministry of Children's Services records, and health records from First Nations communities. Collaboration with First Nations partners would allow for First Nations children to be included in analysis. Collaboration with the Ministry of Children's Services would capture all children in care, and include information on duration of care, care status at time of analysis, and type of child welfare intervention.

Partner agencies. Ministry of Children's Services, Ministry of Health, and First Nations partners.

Suggested Study II

A qualitative study could improve understanding of the context contributing to poor immunization coverage of children in care.

Research questions. What factors influence immunization coverage of children in care? What can be done to improve immunization coverage of children in care?

Design. One of a number of qualitative methodologies based on the specific question.

Data sources. Service providers from both health and children's services agencies and foster parents.

Partner agencies. Alberta Health Services and Ministry of Children's Services to facilitate access to staff members.

Suggested Study III

Based on findings from study II, an intervention study could be conducted with measurement of immunization coverage pre and post intervention. Such studies have been previously completed in the United Kingdom with varying results.[6,9] Identifying successful interventions in a Canadian context would be crucial to addressing this issue.

Research question. Does this intervention improve immunization coverage of children in care?

Design. Intervention study.

Data sources. ImmARI, AHCIP/CSR, Vital Statistics, Ministry of Children's Services records, and health records from First Nations communities.

Partner agencies. Ministry of Health, Ministry of Children's Services, First Nations communities, and Alberta Health Services.

Conclusion

Children in care are a vulnerable population. This study has highlighted that children who have spent time in care experience lower immunization coverage than those who have never been in care. It is imperative that steps are taken so that these vulnerable children do not continue to experience disparity in accessing preventive health services. Nurses are positioned to advocate and take action to be leaders in ensuring the continuity of health care for children in care. Further research to gain a more comprehensive understanding of the issue and to identify effective interventions is needed; policy review and assessment should be performed; and coordinated and collaborative care should be a priority.

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